The American Fertilizer

Vol. 99 SEPTEMBER 25, 1943 No. 7

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Published every other Saturday. Annual subscription: In the United States, $3.00; Canada and Mexico, $4.00; other countries, $5.00. Entered as second-class matter, January 15, 1910, at the Post Office at Philadelphia, Pa. under Act of March 3, 1879. Registered in United States Patent Office. Publication office, 1330 Vine St., Phila., Pa.

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Vol. 99 SEPTEMBER 25, 1943 No. 7

The Preparation of Ammoniam Nitrate For Use as a Fertilizer

Division of Soil and Fertilizer Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, Beltsville, Maryland

Introduction

AMMONIUM nitrate from certain war plants became available for fertilizer use in the spring of 1943. The material shipped was for the most part unsatisfactory from the standpoint of its physical properties. Very severe caking was the chief difficulty encountered. The War Production Board requested the Division of Soil and Fertilizer Investigations to undertake investigations on the production of satisfactory ammonium nitrate fertilizer and to cooperate with producers working on the problem. The Fertilizer Industry Advisory Committee also requested information relating to the use of ammonium nitrate in complete fertilizers. In accordance with these requests three lines of investigation were started: (a) the production of ammonium nitrate fertilizers of satisfactory properties; (b) the use of ammonium nitrate in mixed fertilizers; and (c) the use of ammonium nitrate for top- and side-dressing crops.

This report covers the work to date on (a) the production of ammonium nitrate fertilizers of satisfactory properties. Throughout the investigation progress reports have been exchanged with the Allied War Supplies Corporation, Montreal, Canada, and the Tennessee Valley Authority. A portion of their findings is included in this report but most of the data were obtained in the Division's laboratories.

[1]The experiments reported were conducted by Dr. W. H. Ross, J. R. Adams, J. Y. Yee and V. L. Gaddy. The manuscript was prepared by F. W. Parker.

*Numbers in parentheses refer to literature listed at the end of the article.

Properties of Ammonium Nitrate

Ammonium nitrate possesses several physical properties that distinguish it from other fertilizer materials. A knowledge of these properties is helpful in understanding the behavior of ammonium nitrate and is essential for a satisfactory solution of some of the problems involved in its production and use as a fertilizer.

Hygroscopicity.—The relative hygroscopicity of ammonium nitrate and several other fertilizer salts has been determined by Adams and Merz (1)*. A portion of their data is given in Table I. Ammonium nitrate is the most hygroscopic of the five materials listed. The hygroscopicity of ammonium nitrate varies widely with the temperature. At 50° F. ammonium nitrate is only slightly more hygroscopic than sodium nitrate or ammonium sulphate. The difference increases as the temperature increases. In the case of ammonium nitrate the relative humidity of the air in equilibrium with a saturated solution varies from 75.3 per cent at 50° F. to 48.4 per cent at 104° F., a difference of 26.9. The corresponding difference for sodium nitrate,

TABLE I

RELATIVE HYGROSCOPICITY OF FERTILIZER MATERIALS

Material	Relative Humidity of Air in Equilibrium with a Saturated Solution			
	50° F.	68° F.	86° F.	104° F.
Ammonium Nitrate	75.3	66.9	59.4	48.4
Sodium Nitrate	78.0	77.1	72.4	67.3
Urea	81.8	80.0	72.5	62.5
Ammonium Sulphate	79.8	81.0	79.2	77.8
Potassium Chloride	88.3	85.7	84.0	80.0

urea and ammonium sulphate is 10.7, 19.3, and 2.0, respectively.

Solubility.—Ammonium nitrate is more soluble in water than any of the common nitrogen fertilizer materials, as shown by the data of Table II. It may be noted that the solubility, like the hygroscopicity, of ammonium nitrate is greatly influenced by temperature. On the other hand, temperature has relatively little influence on the solubility of ammonium sulphate. The high solubility of ammonium nitrate and the influence of temperature on solubility are important factors influencing its caking.

TABLE II

SOLUBILITY OF NITROGEN FERTILIZER MATERIALS IN WATER

Temp. °F.	Grams Dissolved by 100 gms. Water: Ammonium Nitrate	Sodium Nitrate	Ammonium Sulphate	Urea
0	118.3	73.0	70.1	66.7
68	187.4	87.6	75.4	108.3
104	280.2	102.0	81.2	166.7
140	418.1	121.7	87.3	250.9
176	635.3	148.1	94.2	400.0

Plasticity.—Ammonium nitrate is somewhat plastic, more so than sodium nitrate. This property was observed in determinations of the crushing strength of granules. Dry granules of most fertilizer materials are brittle and exhibit a sharp crushing point under applied pressure (3). Ammonium nitrate granules also exhibit a sharp crushing strength at 68° F. but at 86° F. and above they tend to undergo deformation under pressure and do not show a sharp crushing point. The presence of moisture seems to increase substantially the plasticity.

The plasticity of ammonium nitrate and other fertilizer materials has not been adequately studied. Such studies will be made in this laboratory in the near future. Observations to date, however, indicate that it is an important property to consider in the shipment and storage of ammonium nitrate in relation to temperature and caking.

Crystal Forms—Transition Points.—Ammonium nitrate exists in five crystal forms depending on the temperature. Form III changes to form IV at 90.1° F with a volume change of approximately 4 per cent. If ammonium nitrate granules pass through this transition point several times, their crushing strength is somewhat reduced. Caking is probably increased by passage through the transition point. This is a property not encountered in any other common fertilizer material. It should be recognized but its importance has sometimes been exaggerated or over-emphasized.

Factors Influencing Caking of Ammonium Nitrate

Ammonium nitrate cakes readily and forms a type of cake that is hard to break down to small particles. This is the result of several properties of the material and the importance of several factors influencing caking must be recognized in order to handle ammonium nitrate satisfactorily.

The principal controllable factors that affect the caking of ammonium nitrate are (1) size of the particles, (2) pressure in storage, (3) temperature of storage, (4) duration of storage, and (5) moisture content.

Experiments have been conducted by the procedure of Adams and Ross (2) to determine quantitatively the influence of these factors on the caking of ammonium nitrate. The method consists of subjecting a small sample of the material to a given pressure in a caking bomb which may be stored at a given temperature for any period of time. On removal from the bomb the small cake or briquette of ammonium nitrate is crushed with a hydraulic press and the crushing strength is expressed in pounds per square inch. Some difficulty has been encountered in securing satisfactory reproducible data with ammonium nitrate. Nevertheless, the data being reported are considered sufficiently accurate for most purposes and adequately indicate the influence of several factors on caking.

Time and Temperature.—The influence of time and temperature on the degree of caking is indicated by the data of Table III. Similar data were secured in another experiment in this laboratory and by Canadian investigators using a different method. Both time and temperature have a great effect on caking and these factors should be given careful consideration in plant operations.

TABLE III

EFFECT OF TIME AND TEMPERATURE OF STORAGE ON THE CRUSHING STRENGTH OF GRANULAR AMMONIUM NITRATE BRIQUETTES

(Applied pressure 12 lbs. per sq. in.)

Storage Temp. ° F.	Crushing strength, lbs./sq. in.: 1 wk.	2 wks.	4 wks.
32	13	—	143
40	48	—	270
50	96	151	342
70	167	287	637

Fluctuations in temperature, especially a drop, are very conducive to caking. This may be related to the high solubility of the com-

pound. With 0.25 per cent moisture and at a temperature of 104° F. one hundred pounds of ammonium nitrate carries 0.70 pound of ammonium nitrate in solution. If the temperature drops to 68° F., 0.23 pound of ammonium nitrate crystallizes from solution and a considerable portion probably acts as a cementing agent, thereby promoting caking.

Particle Size and Moisture.—The influence of particle size and moisture content on the breaking strength of ammonium nitrate briquettes is shown by the data of Table IV.

TABLE IV

EFFECT OF PARTICLE SIZE AND MOISTURE ON THE CRUSHING STRENGTH OF AMMONIUM NITRATE BRIQUETTES

Storage 7 days, 86° F., and 12 lbs./sq. in.

Moisture Content, %	Crushing strength, lbs./sq. in. 40 mesh crystals	10–20 mesh granules
0	22	0
0.2	80	5
0.4	326	35
0.6	>400*	—
1.4	>500*	>500*

*Somewhat plastic, no sharp breaking point.

Increasing the particle size by granulation is one of the best methods of reducing caking of ammonium nitrate. The other effective procedure is to keep the moisture content of the product very low. Under the conditions of this experiment ammonium nitrate of high moisture content is so plastic that there is very little difference in caking between the crystalline and granular forms.

Pressure.—Obviously the amount of pressure to which ammonium nitrate is subjected greatly influences caking. Typical data obtained in our experiments are given in Table V. A pressure of 4 pounds per square inch

TABLE V

EFFECT OF PRESSURE ON THE CRUSHING STRENGTH OF AMMONIUM NITRATE BRIQUETTES

Storage 7 days, 86° F.

Pressure lbs./sq. in.	Crushing strength, lbs./sq. in. 80 mesh crystals	10–20 mesh granules
0	17	0
1	80	—
2	182	—
4	406	0
8	—	24
12	725	111

corresponds to that at the bottom of ten-foot pile of fertilizer. Because of its solubility, plasticity, and other properties, pressure probably influences the caking of ammonium nitrate more than other common fertilizer materials.

Anti-Caking Agents.—Caking of soluble salts may be reduced by the use of small quantities of conditioning agents. The first shipments of ammonium nitrate from Canada and TVA were conditioned with limestone. The Hercules Powder Company conditioned their fertilizer-grade ammonium nitrate with kieselguhr, a material frequently used in certain commercial explosives. An important phase of the experimental work conducted by this Division, TVA and Canadian producers relates to the evaluation of conditioning or anti-caking agents. Probably more than one hundred different materials have been tested in the various laboratories and plants. The results of typical caking tests on conditioned fine crystals of Welland ammonium nitrate are given in Table VI.

TABLE VI

EFFECT OF CONDITIONING AGENTS ON CRUSHING STRENGTH OF BRIQUETTES OF WELLAND CRYSTAL AMMONIUM NITRATE

Storage 7 days, 86° F., 12 lbs./sq. in.

Conditioning Agent	Crushing strength, lbs./sq. in. 3% added	6% added
None	374–450	
Dolomite, <200 mesh	302	429
Limestone, 60–100 mesh	195	278
Limestone, <200 mesh	357	342
Talc	405	413
Kieselguhr	190	140
Kaolin	246	119
Tricalcium phosphate, pptd.	33–64	56–72
Miami soil colloid	215	156
Dewey soil colloid	49	—
Cecil clay colloid	30	12
Iron oxide, Fe_2O_3	302	295
Bentonite, unheated	264	—
Bentonite, heated, 500° C.	134	85

>10 mesh	0 per cent
10–20 mesh	32.5 per cent
20–28 mesh	37.0 per cent
28–35 mesh	17.8 per cent
35–65 mesh	11.5 per cent
<65 mesh	1.3 per cent
Total	100.0 per cent

The results of our tests on anti-caking conditioning agents are summarized as follows:

1. Limestone, dolomite and rock phosphate containing calcium carbonate are not satisfactory conditioning agents. These materials react with ammonium nitrate with slight loss of ammonia as indicated by laboratory experiments, observations in plants, and the presence of free ammonia in shipments of nitrate conditioned with limestone.
2. Kieselguhr and kaolin are effective conditioning agents. This has been conclusively shown by the work of Hercules Powder Company, and the more recent experience of TVA and Canadian plants.
3. The chemical constitution and physical properties of clays influence their anti-

caking properties as indicated by the observed differences between various soil colloids, kaolin, and heated and unheated bentonite.

Most of the work of this Division on the evaluation of different kinds and amounts of anti-caking agents has been with crystalline ammonium nitrate. Hercules Powder Company and TVA have evaluated them in the graining method of granulation. Some work has been done on their evaluation when used with spray granulated ammonium nitrate, Nitraprills, both uncoated and coated with a moisture repellent. Additional work on the latter phase of the problem, including the influence of moisture repellents on caking, is in progress.

Large-Scale Storage Tests.—A bag storage test with some of the newer forms of ammonium nitrate was started in Cambridge, Mass. the latter part of June. A similar test, including a number of experimental materials, was started at Beltsville the middle of August. A third storage experiment will be started in Norfolk in the near future. These and similar tests by the producers, constitute the first long time bag storage tests with ammonium nitrate in a form approximating what is now believed to be the best for fertilizer purposes.

Granulation

Granulation of ammonium nitrate is essential for the production of a suitable fertilizer for direct application. It is also an important step in the solution of the problem of caking in shipment and storage.

TVA has granulated ammonium nitrate by graining, utilizing the graining equipment previously installed. A recent shipment of TVA ammonium nitrate conditioned with 1 per cent petrolatum and 4 per cent kaolin showed the following screen analysis:

The percentage of particles smaller than 20 mesh is greater than is desirable for top- and side-dressing purposes. The TVA product would be improved by an increase in the particle size.

After experiments with different methods of granulation Canadian producers adopted the spray or shotting method. Initial production was by Alberta Nitrogen Products, Ltd., Calgary, Alberta, but Welland Chemical Works will start production in September. Canadian Nitraprills pass a 6-mesh screen. Initial shipments contained up to 15 per cent passing a 22-mesh screen. Fines are now removed by screening so that the fraction passing 22-mesh is less than 5 per cent at point of shipment. As regards particle size distribution the Canadian product is excellent for top- and side-dressing purposes.

Physical Properties of Granules.—The crushing strength of Nitraprills has been determined and found to be satisfactory. Alberta Nitrogen Products has studied several factors influencing the strength and density of the granules as well as their resistance to abrasion. Additional work of this nature is required to improve further the product. The work will include studies on the influence of moisture repellent coatings on the physical properties of the granules.

Moisture Repellent Coatings

As indicated in Table I ammonium nitrate is the most hygroscopic of the common fertilizer materials. Work has, therefore, been conducted with the objective of developing a method for satisfactorily overcoming this objectionable property.

The explosives industry has used petrolatum and similar material to reduce moisture absorption by ammonium nitrate. Experiments in this field were conducted by the Fixed Nitrogen Research Laboratory following the First World War.

TABLE VII

RATE OF MOISTURE ABSORPTION BY COATED AND UNCOATED GRANULAR AMMONIUM NITRATE (10–20 MESH) AT 86° F. IN A RELATIVE HUMIDITY OF 72.5 PER CENT

Coating Agent	Per Cent of NH_4NO_3	Time of Exposing 2 hrs.	4 hrs.	6 hrs.
None	None	13.54	26.30	38.04
Petrolatum	0.2	10.10	11.77	12.76
Petrolatum	0.5	4.56	5.96	6.32
Petrolatum	1.0	2.31	2.86	3.26
Paraffin	0.2	5.48	9.11	11.42
Paraffin	0.5	5.30	8.97	11.28
Paraffin	1.0	4.26	7.24	9.11
Petrolatum + rosin	0.5	6.43	7.98	8.22
Paraffin + rosin	0.5	4.02	6.70	8.50
Petrolatum + paraffin + rosin	0.2	1.05	1.66	2.18
Petrolatum + paraffin + rosin	0.5	0.49	0.74	0.92
Petrolatum + paraffin + rosin	1.0	0.48	0.71	0.92
TVA Petrolatum	1.0	2.65	3.72	4.53

Our experiments have been limited to coating 10–20 mesh granular ammonium nitrate from Calgary with various materials and determining moisture absorption by the resultant product. The coating agent has been applied in a solvent which is later volatilized or as a spray. The two methods give essentially the same result. The former is more convenient in the laboratory while the latter would be used in commercial operations. Moisture absorption is determined by sub-

(*Continued on page 22*)

The American Chemical Society

Abstracts of Papers Presented at the Meeting of the Division of Fertilizer Chemistry at Pittsburgh, Pa., September 6 to 10. 1943, H. B. Siems, Presiding

Variance in Chemical, Optical, Structural, and Fertilizer Properties of Commercial Precipitated Tricalcium Phosphates

W. H. MacIntire and S. H. Winterberg, University of Tennessee, Agricultural Experiment Station, Knoxville, Tenn., and H. L. Marshall, George Palmer, and B. W. Hatcher, Tennessee Valley Authority

The over-all problem of precipitated tricalcium phosphates is one of great importance to the fertilizer industry, to the chemist charged with water defluorination, and in chemical and biochemical investigations.

In recognition of the uncertainty as to composition and properties of commercial precipitated tricalcium phosphates, seven samples were obtained from dependable vendors and submitted to chemical, optical, powder diffraction and Neubauer tests, and to pot culture studies. Monocalcium phosphate, five purchased dicalcium phosphates, and three prepared tertiary products were included as controls.

The dicalcium phosphates were virtually citrate-soluble and of uniform P_2O_5:CaO ratio. The tertiary precipitates varied in composition, solubility, reactivity toward calcium fluoride, in optical properties, X-ray powder diffractions, in Neubauer tests, in plant response, and in P_2O_5 recovery. Five precipitates were isotropes and two were anisotropes. Four of the precipitates were hydroxyapatites, three were similar to but not identical with beta $Ca_3(PO_4)_2$. Solubility varied from 34 to 96 per cent. Two lots from the same vendor varied 100 per cent in solubility. Variance in P_2O_5 uptake by Neubauer seedlings, in plant response, and in P_2O_5 recoveries were consonant with the values registered by chemical examinations of the precipitates. It is proposed that a standardized and certified precipitated tricalcium phosphate be provided as a control in chemical and biochemical research.

Factors Affecting the Determination of Acid- and Base-Forming Quality of Fertilizers

H. R. Allen and Lelah Gault, Kentucky Agricultural Experiment Station

The relation between the amount of dolomite present in samples of mixed fertilizer and the amount of normal HCl in the digestion mixture was investigated when the digestion was made with beakers in the water bath, on the sand bath, and on the hot plate. Digestion on the sand bath or hot plate was found to be more effective than in the water bath for amounts of dolomite above 500 pounds per ton, using a 1-gram sample. Increasing the amount of normal HCl was found to be more effective than increasing the concentration by reduction of volume of water added. A 1-gram and a 0.5-gram sample were compared in determining the basicity of mixed fertilizers, and a 0.5-gram and a 0.25-gram sample were compared in determining the basicity of the dolomite alone. A 0.5 molar sodium carbonate solution was found to be satisfactory. Ashing temperatures of 500° and 600° C. in volatilizing the nitrogen in the sample were compared and results indicated that 500° C. was too low for this purpose.

A major factor in determining basicity of dolomite coarser than 20-mesh in mixed fertilizers is the difficulty of obtaining uniform portions from the unground sample. This was investigated in mixtures containing from 25 to 150 pounds of coarser-than-20-mesh dolomite per ton. Results were duplicated within 10 pounds per ton for the lower amounts of dolomite and within about 15 pounds per ton for the higher amounts.

The Preparation of Ammonium Nitrate for Use as a Top Dressing

William H. Ross, J. Richard Adams, and J. Y. Yee, Division of Soil and Fertilizer Investigations, U. S. Department of Agriculture, Washington, D. C.

The consumption of ammonium nitrate in the United States during the past 15 years varied from a minimum of about 1000 tons in 1932 to a maximum of about 68,000 tons in 1937. During this period it was not marketed as such but in association with other materials to form the products known as Nitrogen Solution, Leunasaltpeter, and Calnitro.

The properties of ammonium nitrate that tend to limit its use as a fertilizer are its marked tendency to cake, its high hygroscopicity, and its combustibility. The caking tendency of ammonium nitrate may be reduced by granulating and by coating the granules with a finely divided water-insoluble

material such as kaolin, kieselguhr, and tri-calcium phosphate. Materials such as limestone and dolomite which react with ammonium nitrate do not make satistactory coating agents. The effectiveness of a coating agent, when other factors are the same, appears to increase, with decrease in the fineness of its particles. A finely divided coating material has little or no effect in reducing the rate at which ammonium nitrate absorbs moisture from the air. This can be decreased by coating the granules with a water-repellent material such as an oil, paraffin, or wax. The most effective treatment for maintaining ammonium nitrate in a satisfactory condition thus consists in (1) granulating; (2) coating the granules with a water-repellent material such as paraffin, followed by a second coating with a finely divided material such as kieselguhr; and (3) storing in moistureproof bags.

The humidity at which ammonium nitrate begins to absorb moisture from the air decreases with increase in the temperature. Thus, absorption of moisture takes place when the relative humidity exceeds 52.5 per cent at a temperature of 40° C. but not until the humidity exceeds 75.3 per cent when the temperature drops to 10° C. The behavior of ammonium nitrate with respect to moisture absorption will thus vary greatly in different sections of the country, and in certain sections at different periods of the year.

Ammonium nitrate will melt, decompose, and ignite at a temperature just below redness. Heat of combustion is relatively low and combustion of the material will, therefore, not ordinarily be maintained unless heat is supplied from some outside source. The addition of any normal amount of ammonium nitrate to a mixed fertilizer of the ordinary type does not increase its fire hazard, but admixture of the material with any considerable quantity of an organic material is not to be recommended.

Ammonium Nitrate as a Component of Mixed Fertilizers

John O. Hardesty, J. Y. Yee, and V. L. Gaddy, Division of Soil and Fertilizer Investigations, U. S. Department of Agriculture, Washington, D. C.

An experimental study was made of the hygroscopicity and rate of moisture absorption at different humidities of a large number of mixed fertilizers of varying types. The mixed fertilizers used in the tests were formulated with a view to determining the effect of ammonium nitrate on the mechanical condition of different grades and types of mixed fertilizers. The ammonium nitrate in the mixtures was varied from 0 to 200 pounds per ton. These mixtures were prepared so as to show the effect on ther hygroscopicity and moisture absorption rate of (1) several basic conditioning agents; (2) different proportions of the potash carriers; and (3) various combinations of the most commonly used nitrogen compounds. It was found that:

1. The maximum quantity of ammonium nitrate that can be used in a fertilizer mixture without seriously impairing its mechanical condition varies greatly with the nature of the materials with which it is associated in the mixture.

2. A mixture that is less hygroscopic than another may nevertheless exhibit a higher rate of moisture absorption when the humidity is above the hygroscopic point of both.

3. The hygroscopicity of mixed fertilizers containing ammonium nitrate varies greatly with the potash carrier used in the mixture. Those containing potassium sulphate are the least hygroscopic, and those containing the manure salts are the most hygroscopic.

4. The addition of two units of ammonium nitrate and the necessary quantity of ammonium sulphate to an ammoniated 5–10–5 mixture in which the potash was derived from potassium sulfate showed a lower rate of moisture absorption than one in which the ammonium nitrate was entirely replaced by ammonium sulphate and the potassium sulphate by manure salts.

5. The rate of moisture absorption of a complete mixture in which were included 1¼ units of nitrogen as free ammonia, 1¾ units as ammonium sulphate, and 2 units as ammonium nitrate increased with increase in the content of potassium chloride.

6. Mixtures containing ammonium nitrate that have been conditioned by ammoniation or by treatment with lime or cyanamide are superior in their mechanical condition to the corresponding mixtures that have not been conditioned.

7. The rate of moisture absorption of an ammoniated 5–10–5 mixture containing sodium nitrate, ammonium sulphate, and a high grade muriate was reduced at humidities above 70 per cent when the sodium nitrate was replaced by an equivalent quantity of ammonium nitrate or urea.

Ammonium Nitrate in Mixed Fertilizers

Arthur M. Smith, Synthetic Nitrogen Products Corporation, New York, N. Y.

The required physical condition is the chief factor limiting the quantity of ammonium nitrate per ton of mixed fertilizer. Tempera-

ture and humidity prevailing from the time of first mixing until final use of the fertilizer must be taken into consideration.

Factors favoring the maximum use of ammonium nitrate per ton of complete fertilizer are: dry mixing; neutralizing the superphosphate with some active form of lime to the point of changing all monocalcium phosphate to dicalcium phosphate; high potash analyses; absorbent organic nitrogen materials; additional sulphate either as sulphate of ammonia or sulphate of potash; dry inert fillers. In dry mixing an average safe maximum is one pound of ammonium nitrate to five pounds of superphosphate.

When mixing with aqua ammonia solutions of ammonium nitrate, more ammonium nitrate can be used per ton of complete fertilizer at an ammoniation rate of 20 to 25 pounds NH_3 per 1000 pounds superphosphate than when 30 pounds NH_3 or more per 1000 pounds superphosphate are used. With a low rate of ammoniation, dry solid ammonium nitrate can be added to obtain a higher total than when all of the ammonium nitrate is derived from solutions.

When using hygroscopic materials such as ammonium nitrate, a proper balance between the moisture-combining and the moisture-supplying compounds (water capacity vs. water load with an adequate margin of safety) is important and should be observed. In general, mixing the complete fertilizer direct to analysis, curing in bulk, and bagging at shipping time without any additions or changes of any kind permit the use of larger quantities of ammonium nitrate.

Technology of Borax Production as Practiced by Pacific Coast Borax Company

George A. Connell, Pacific Coast Borax Company, 51 Madison Avenue, New York, N. Y.

THE production of borax by the Pacific Coast Borax Company is divided into two distinct types of operation. The first is the mining of the ore and the second is the conversion of this ore into refined borax.

The ore lies in a body approximately 400 feet beneath the surface and is mined by the so-called shrinkage-stope method. The ore is raised to the surface by means of a hoist, crushed, and shipped to Wilmington, Calif. At Wilmington the refining operation takes place. The borax is unloaded from cars by means of a vacuum conveyor system. The water-soluble constituents of the ore are dissolved in water at high temperatures. The insoluble constituents are removed and the borax is crystallized out of solution by cooling and then centrifuged and dried. The borax is screened to various meshes and a considerable portion of it is ground to make powdered and impalpable borax. Borax is also used as a starter material for making other borate products as well as in the manufacture of boric acid. The various steps in the refining are described.

Production of Borax From Searles Lake Brine, American Potash & Chemical Corporation Process (Supplementing Moving Picture Film)

R. M. Curts, American Potash & Chemical Corporation, New York, N. Y.

The Searles Lake salt deposit, located on the Mojave desert, consists of a porous crystalline mass permeated by a dense alkaline brine, containing essentially sodium and potassium borates, chlorides, sulphates, and carbonates. The brine is removed from wells, approximately 70 feet below the surface, and pumped about four miles to the plant where, after mixing with plant end liquors, it is sent to large triple-effect evaporators, concentrated, and separated into various salts, including borax, by carefully controlled "fractional" crystallization based on phase rule data. The solubilities of the carbonate, sulphate, and chloride of sodium being much lower, a large portion thereof is first precipitated and removed from the system. After further evaporation of the borax-potassium chloride-rich fraction, the potassium chloride is removed by rapid cooling under vacuum and then by further cooling, a crude borax is crystallized. This is redissolved in hot water, filtered, and recrystallized in pure form by controlled cooling in vacuum crystallizers. It is then dried and passed over a magnetic separator, as a final precaution against iron contamination. Subsequently, it is classified by screening.

Boron Tests and Determination for Soils and Plants

K. C. Berger and Emil Truog, University of Wisconsin

Of the boron tests considered during the past five years, the one (colorimetric) based on the quinalizarin reaction has given by far the most satisfactory results for the determination of boron in soils and plants. The method based on this reaction is both rapid and accurate. Since publication of the method as originally used, a number of improvements in the procedure have been made.

It has been found that when the two reagents which are used in developing the color, namely, the quinalizarin solution and 98 per cent sulphuric acid, are combined as one

(Continued on page 20)

THE AMERICAN FERTILIZER
ESTABLISHED 1894
PUBLISHED EVERY OTHER SATURDAY BY
WARE BROS. COMPANY
1330 VINE STREET, PHILADELPHIA, PA.

A MAGAZINE INTERNATIONAL IN SCOPE AND CIRCULATION DEVOTED EXCLUSIVELY TO THE COMMERCIAL FERTILIZER INDUSTRY AND ITS ALLIED INDUSTRIES

PIONEER JOURNAL OF THE FERTILIZER INDUSTRY

WARE BROS. COMPANY
PUBLISHERS
1330 VINE STREET PHILADELPHIA, PA.
A. A. WARE, EDITOR

ANNUAL SUBSCRIPTION RATES

U. S. and its possessions, also Cuba and Panama.....$3.00
Canada and Mexico 4.00
Other Foreign Countries 5.00
Single Copy ..... .25
Back Numbers ..... .50

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Vol. 99 SEPTEMBER 25, 1943 No. 7

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Ceiling Prices Set for Nitrogenous Tankage, Sewage Sludge and Castor Pomace

Sales to fertilizer manufacturers of three critically needed nitrogenous raw materials—the principal sources of organic nitrogen in the manufacture of mixed fertilizer—were supplied with dollars-and-cents prices by the Office of Price Administration on September 18th.

All bulk sales of process tankage and sewage sludge, and sales of bagged castor pomace and castor cake by producers and jobbers were brought under the provisions of a new regulation, Maximum Price Regulation No. 470 (process tankage, sewage sludge, castor pomace and castor cake). Effective September 23, 1943, specific ceiling prices per unit of ammonia, f. o. b. producing point, are set for domestic materials.

Previous to issuance of MPR 470, the prices of these nitrogenous materials had been regulated by the General Maximum Price Regulation on the basis of each seller's highest price charged during March, 1942. In setting uniform ceilings for all producers, this new action lowered the prices of some and raised the prices of a few—the general effect being to restore the normal relationship between various materials at their different points of production.

Maximum prices set, f. o. b. plant, are as follows:

(a) For process tankage, in bulk.

Production point:	*Price per unit of ammonia*
Norfolk, Virginia	$3.50
Carrollville, Wisconsin	3.20
Endicott, New York	3.20
Carteret, New Jersey	3.15
Chemical, Illinois	3.15

(b) For dried activated sewage sludge, in bulk.

Production point:	*Price per unit of ammonia*
Milwaukee, Wisconsin	$3.00
Chicago, Illinois	2.80
Houston, Texas	2.60

In addition to the above, the seller may make a charge of 40 cents per unit of available phosphoric acid.

(c) For castor pomace, in bags: $2.90 per unit of ammonia.

(d) For unground castor cake, in bags: $15.50 per ton.

Ceiling prices have been set by OPA with the intent of inducing maximum production

in the face of the present critical shortage of organic nitrogen. Maximum production, OPA said, can be realized only by the utilization of additional quantities of low-grade, high-cost raw materials for process tankage.

Many Farms Idle

The Bureau of Census reports 76,704 idle and abandoned farms in the United States as of April, 1940, representing 6,484,292 acres. Most of these were in the New England and Middle Atlantic States, where one out of every 20 farms was idle. Worn out land and crop failures accounted for a third of the total abandonments, with some 12,000 left idle by farmers taking other jobs. The same report also shows there were 56,000,000 idle acres on producing farms.

Less Leaching from Neutral Soils

Leaching of nitrogen and potash from sandy soils is much less for nearly neutral soils than for highly acid soils, reports G. M. Volk, Florida Station chemist. Fertilizers consisting of ammonium nitrate and potassium sulphate were applied in solution at high rates to light sandy soil in lysimeters and leaching measured after 18 hours. Norfolk light sand with a pH of 3.98 lost 43.5 per cent of the nitrogen and 33.3 per cent of the potash applied; with a pH of 5 46 it lost 20.9 and 19.7 per cent of nitrogen and potash; at a pH of 6.3 the losses were 12.8 and 13.7 per cent; and at pH 6.85 losses were only 6.9 and 9.6 per cent of nitrogen and potash, respectively.

White Appointed to Industry Committee

Nelson T. White, The Smith Agricultural Chemical Company, Saginaw, Mich., has been appointed a member of the Fertilizer Industry Advisory Committee to take the place of M. K. Derrick, who has entered Government service.

Maine Fertilizer Sales

A survey of fertilizer sales by grades for the year ended June 30, 1943, has been completed by Dr. J. A. Chucka, agronomist of the Maine Experiment Station. Sales totaled 204,428 tons averaging 27.2 per cent of total plant food. Aroostook County used 157,987 tons or 86 per cent of the total. The sale of unapproved grades left over in the hands of agents and dealers amounted to only 618 tons.

Derrick Receives WFA Appointment

M. K. Derrick has been appointed chief of the Fertilizer Division, Chemicals and Fertilizers Branch, Office of Materials and Facilities, War Food Administration. Mr. Derrick is experienced in the fertilizer business through his connection with the Indiana Farm Bureau Cooperative Association. In addition, he has had ten years' experience as a county agent. He is well known to members of the industry, having previously served as consultant to WPB and in an advisory capacity to WFA in connection with fertilizer distribution problems.

Italian Fertilizer Situation Appears Favorable

Agricultural production in Italy during the 1943–44 crop year is not expected to be handicapped by any serious lack of commercial fertilizers, unless the Nazis damage or requisition the output of domestic plants which in recent years have supplied most of the country's nitrogenous fertilizer requirements, the Department of Agriculture recently pointed out. Adequate phosphate should be available from North Africa. Potash, heretofore supplied almost entirely by Germany, constitutes a very minor part of Italy's annual commercial fertilizer consumption.

Although now producing most of its nitrate requirements at home, Italy has always been dependent upon foreign countries for virtually all of its large consumption of phosphate as well as for its relatively small consumption of potash, according to the Department's Office of Foreign Agricultural Relations. The United Nations occupation of North Africa in late 1942 and early 1943 temporarily cut off that area as a source of supply for phosphates. The recent unconditional surrender of Italy closed Germany as a source of supply for potash, but it reopened North Africa as a source of phosphates.

From 1939 to 1942 Italy was in a position to receive shipments of phosphate rock from North Africa via the Mediterranean and potash salts from Germany, largely through the Brenner Pass. These imported fertilizers, together with domestic production of nitrogenous materials, have been sufficient to maintain food production at a satisfactory level under a food rationing system which was not considered to be particularly burdensome. In fact substantial quantities of Italian foodstuffs were exported to Germany. If Italian farmers are freed of the necessity of providing

the Nazis with large quantities of farm products they should find little difficulty, other things being equal, in producing enough food during the new crop year to meet the minimum needs of the people.

Even before the war Italy had ample facilities to produce nitrogenous materials for fertilizer use, although imports of Chilean nitrate of soda were made regularly, principally for use in the intensively farmed valleys of Northern Italy. Although imports from Chile have been cut off, the belief is that increased domestic production has more than offset the loss of supplies from that country. Total Italian consumption of commercial nitrogen, in terms of elemental nitrogen, amounted to 148,000 short tons in 1938, compared with 153,000 tons in 1937. The average consumption during the 5-year period 1929–1933 was only 74,000 tons.

Coke ovens producing synthetic by-product sulphate of ammonia are scattered widely throughout Italy, as are also the synthetic plants for the production of calcium nitrate, ammonium nitrate and cyanamide. The extent to which these plants can continue to produce nitrogenous materials will depend, of course, on whether or not the Germans will damage or take them over and on whether sufficient electrical power and coal continue to be available.

The Italian production of phosphate rock, about 300 tons annually, is only an insignificant part of the total requirements of that fertilizer material. Expressed in terms of the total phosphoric oxide (P_2O_5) content of various commonly used phosphorus carriers, the consumption of phosphorus in Italian agriculture during 1938 amounted to 272,000 tons compared with 253,000 tons in 1937 and an average of 219,000 tons for the 5-years 1929–1933.

In 1939 Italy imported 1,060,000 tons of phosphate rock compared with 927,000 tons in 1938 and 742,000 tons in 1934. Since 1934 over 75 per cent of the imports came from French North Africa. Most of the balance came from the United States and the Soviet Union, but none has been imported from the United States since 1939 and none from Russia since 1937.

It is believed that until quite recently Italy has been able to import sufficient phosphate rock from North Africa to maintain a normal production of superphosphate and that Italian soils, as a result, have not been impoverished during the past 2 or 3 years. Even should shipping difficulties make it impossible to import the usual quantities from North Africa this year, agricultural output is not likely to be affected unfavorably because farmers have been able to apply large quantities of phosphates regularly for a number of years.

Potash consumption by Italian agriculture is quite small compared with nitrogen and phosphates, said the Department. Total consumption in 1938 amounted to only about 20,000 tons in K_2O equivalent compared with 17,000 tons in 1937. A few hundred tons of potash material obtained as a by-product residue from sugar-beet factories represents the entire domestic production. The balance had to be imported, largely from Germany.

The quantity of fertilizer materials used in Italy has increased steadily in the past 14 years, said the Department. Compared with the average for the 5–years 1929–1933 the consumption during the 5–years 1934–1938 averaged 7.8 pounds per acre for nitrates against 4.4 pounds in the earlier period, 14.9 pounds for phosphates (P_2O_5) against 13.1 pounds, and 1.4 pounds for potash (K_2O) against 1.1 pounds. In the last two or three years the lack of power, together with transportation difficulties and a scarcity of raw materials, forced a reduction in consumption, constituting an important drawback in the Government's efforts to expand agricultural production.

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FERTILIZER MATERIALS MARKET

NEW YORK

Larger Fertilizer Sales Expected. Improvements on Mechanical Condition of Ammonium Nitrate Reported. Lend-Lease Shipments Hamper Potash Deliveries to Domestic Producers. Improvement in Castor Pomace Situation Possible.

Exclusive Correspondence to "The American Fertilizer"

NEW YORK, September 21, 1943.

Fertilizer manufacturers have been extremely busy and from all indications there will be a considerable increase in the sales of fertilizer for the present season over the previous year.

Sulphate of Ammonia

Shipments have continued against contract orders, no additional allocations having been made.

Nitrate of Soda

This material has moved steadily against contracts and no new allocations have been made for this material.

Ammonium Nitrate

There has been considerable experimentation going on in order to make this material a more satisfactory fertilizer ingredient and some deliveries have now been made of this material which has been treated with a coating which is supposed to prevent caking and the absorption of moisture.

Potash

This material has been moving steadily against contracts but, with the demand for export shipments against Lend-Lease, some of the domestic buyers have not received all the material that they would like. There is some possibility that the total quantity allocated for this delivery against Lend-Lease may be reduced but the October and November quotas are being ordered out so that any reduction would only affect a later position. A reduction in the allocation for Lend-Lease would be a tremendous benefit to the domestic situation as, with the quantities designated for export, there is certainly going to be a pinch felt in this market.

Superphosphate

There has been no change in the situation with no indication that sulphuric acid can be made available for the maximum quantity which the Government would like.

Castor Pomace

This material is still scarce but some sales have been made to regular buyers within the last few weeks and if the importation of beans continues in fair quantity, there may be a slightly better situation prevailing in this market.

CHARLESTON

New Prices Announced on Nitrogenous, Activated Sludge and Castor Pomace. Superphosphate Production Declines.

Exclusive Correspondence to "The American Fertilizer"

CHARLESTON, September 20, 1943.

Nitrogenous.—There are still no further allocations of this material. The Nitrogen Unit of WPB has fixed the following ceiling prices effective September 23rd, per unit of ammonia, f. o. b. Norfolk, $3.50; Carrollville, $3.20; Endicott, $3.20; Carteret, $3.15; Chemical, Ill., $3.15. On activated sludge, the ceiling is: Milwaukee, $3.00; Chicago, $2.80.

Castor Pomace in bags has been given a ceiling of $2.90; unground castor in bags, $15.50 per ton, f. o. b. producing points.

Dried Blood.—There is no change in this situation, whatever material has arrived from South America has gone to feed.

Superphosphate.—Contrary to expectations, the June-July productions were less than the same months of 1942.

Cottonseed Meal.—The 8 per cent grade is priced at $46.50 in Georgia, $47.00 in South Carolina, plus cost of bags at the mill.

FERTILIZER MATERIALS

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NITRATE *of* SODA

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POTASH SALTS

DRIED BLOOD

TANKAGES

COTTONSEED MEAL

BONE BLACK

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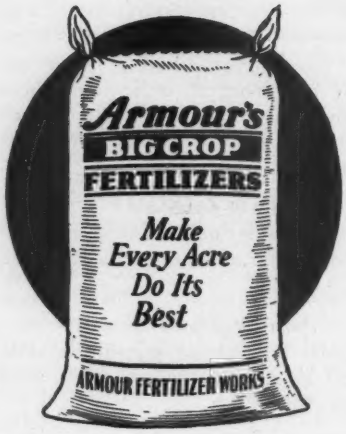
SODIUM FLUOSILICATE



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Wilmington, N. C.

BALTIMORE

Ceiling Prices on Nitrogenous and Castor Pomace Announced. Prices on Sulphate of Ammonia and Nitrate of Soda Unchanged. Shortage of Sulphuric Acid.

Exclusive Correspondence to "The American Fertilizer"

BALTIMORE, September 21, 1943.

Business in fertilizer materials continues quiet, and the announcement of ceiling prices on nitrogenous material and castor pomace were the outstanding features of the fertilizer situation during the past two weeks.

Ammoniates.—Practically the entire production of packing house tankage and blood is going into the consumption of feeding materials at feeding material prices which are out of reach as far as fertilizer is concerned. Ceiling prices, however, have been announced on nitrogenous material on the basis of $3.50 per unit of ammonia ($4.25½ per unit N), f. o. b. producers' works Norfolk, with slightly less being quoted at other producing points.

The price of castor pomace has been fixed at $2.90 per unit of ammonia ($3.52½ per unit N), per ton of 2,000 pounds, in bags, or $15.50 per ton for castor cake, f. o. b. New York City producers' works.

Sulphate of Ammonia.—This material is still being delivered on allocation basis, but in decreased volume, with offerings of ammonium nitrate as a substitute, but this has not met with any ready acceptance by the trade due to physical properties of goods which will have to be overcome before it can be considered an acceptable substitute. The price on sulphate of ammonia, as previously announced, remains unchanged for such tonnage as is obtainable.

Nitrate of Soda.—The price on this also remains unchanged, and deliveries continue to be allocated.

Fish Meal.—There is no change in the situation and practically the entire production of Chesapeake Bay scrap is now going into the manufacture of fish meal.

Superphosphate.—There are no offerings on the market which remain at 64 cents per unit of A. P. A. for run-of-pile, f. o. b. producers' works, Baltimore. Efforts to induce the Government officials to release sulphuric acid to permit increase in production of superphosphate have been unavailing up to the present time.

Bone Meal.—There is no change and the nominal market on 3 and 50 per cent steamed bone meal and 4½ and 47 per cent raw bone meal is $50.00 per ton, f. o. b. Baltimore.

Bags.—While there has been an easing up on the part of the Government restrictions surrounding the use of burlap bags, up to the present time there has been no change as far as fertilizer is concerned, although some manufacturers are still hopeful of securing authority to ship in new burlap bags to such of their buyers who are desirous of securing these bags for further re-use.

PHILADELPHIA

Trade Interested in Ceilings on Nitrogenous and Castor Pomace. Sulphate of Ammonia Allocations Granted in Full.

Exclusive Correspondence to "The American Fertilizer"

PHILADELPHIA, September 27, 1943.

Attention during the last couple of weeks was centered in the announcement of ceiling prices for nitrogenous tankage, castor pomace and sewage sludge. The ceilings were placed at just about the same levels as the previously prevailing prices for these commodities, with the slight change in the castor pomace price, due to putting the ceiling price on a unit basis, instead of on the flat-ton basis, as it was generally sold heretofore.

Ammoniates.—The importations of animal by-products from South America seem to continue, but all of this now goes to the feeding trade. Otherwise, as stated above, interest was focused on the price ceilings established

Manufacturers' Sales Agents for **DOMESTIC**

Sulphate of Ammonia

Ammonia Liquor :: Anhydrous Ammonia

HYDROCARBON PRODUCTS CO., INC.

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for nitrogenous tankage, castor pomace, and sewage sludge.

Sulphate of Ammonia.—It is reported that all requests for allocation of this commodity were granted in full. The price continues, of course, on the same level.

Nitrate of Soda.—October prices apparently are to remain the same as prevailed for September.

Superphosphate.—While demand for deliveries against contracts is brisk, yet the supply situation appears to be such as to take care of all requests for delivery.

Bone Meal.—Supply still remains low, with a consequent firm position in the material being maintained.

Potash.—Shipments against contracts were apparently the main feature of this market. Supply situation seems to hold its own, although demand from all users is brisk.

CHICAGO

Little Fertilizer Organic Material Offered for Later Delivery. Shortage in Feed Materials Despite Imports.

Exclusive Correspondence to "The American Fertilizer"

CHICAGO, September 20, 1943.

The organic situation remains unchanged. Steady demand continues, but sellers are apparently unable or unwilling to make offerings, especially for later deliveries. This is presumably caused by the unsettled conditions as to supplies, labor and the threatened price roll-back.

In the feed market the situation is likewise unchanged. Decided shortages in various feeds is being constantly demonstrated. While the import of South American dry rendered tankage has been some relief, it has not filled the nation-wide feed demand.

No change in ceiling prices has occurred.

High grade ground fertilizer tankage, $3.85 to $4.00 ($4.68 to $4.86 per unit N) and 10 cents; standard grades crushed feeding tankage, $5.53 per unit ammonia ($6.72 per unit N); blood, $5.38 ($6.54 per unit N); dry rendered tankage, $1.21 per unit of protein, Chicago basis.

TENNESSEE PHOSPHATE

Phosphate Shipments Active but Labor Shortage Proves Big Handicap. More Rock Going into Feed Manufacture.

Exclusive Correspondence to "The American Fertilizer"

COLUMBIA, TENN., September 20, 1943.

Shipments of rock are active into all consuming channels, especially ground rock to farmers for direct application, which is now at seasonal pitch. Labor for bagging and loading is so lacking because of war plants and the draft that some shippers are getting only half the normal machine capacity. Bulk shipments are getting out more rapidly as they require only half the labor.

More ground rock is moving to the mineral feed manufacturing industry than ever before. The International Minerals & Chemical Corp. has established plants in the South for defluorinating phosphates and report a large business in this product.

Most of the mining companies in the Mt. Pleasant district are belatedly recognizing the necessity of adding to their holdings of phosphate reserves, as the rate of depletion has more than doubled in recent years. In general the plan of bringing the raw matrix from distant areas to existing plants is being followed but as soon as new plants are permitted to be constructed, they will be established more widely over the main Tennessee phosphate counties.

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THE AMERICAN CHEMISTRY SOCIETY

(*Continued from page 11*)

reagent, speed and accuracy of the determination are expedited. Also, it has been found that full color development can be obtained quickly if the solution is cooled to approximately 25 degrees C. With the improved procedure one operator can easily average 25 determinations in a normal working day.

The colorimetric comparison involved can be made satisfactorily, either by direct visual observation or by use of a photoelectric colorimeter. In the latter case, a 620 millimicron filter has given the best results. When the photoelectric procedure is followed, it is necessary that the glass of the comparator tubes or vessels be absolutely free of strains, scratches, and flaws, because the very high index of refraction of the solution used magnifies the influence of these imperfections.

Some Calcium-Boron Interrelationships in Plants

H. E. Jones and G. D. Scarseth, Purdue University Agricultural Experiment Station, Lafayette, Indiana

In greenhouse plot experiments with several common Indiana field crops on a Crosby silt loam soil, some relationships between calcium and boron have been studied. The lack of adequate nitrogen, phosphorus, or potassium markedly decreased the yields of the various crops but did not effect the ratio of plant adsorption for calcium and boron. In general the optimum molecular ratio of calcium to boron was in the neighborhood of 1200 for tobacco, 500 for soybeans, and 100 for sugar beets. When the plant intake of calcium was low, as with the acid soil, a calcium-boron ratio below the optimum tended to produce boron toxicity. When the quantity of calcium intake was high, such as in the heavily limed soil, the plants tended to show a boron deficiency. The relationship of calcium to boron as expressed in the molecular ratio of these elements in the plant appears to offer a possible approach to predicting the need for boron as well as to indicate where the application of boron may cause toxicity.

Potassium-Boron and Calcium-Boron Relationships in Plant Nutrition

John W. Shive and Eldrow Reeve, New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, N. J.

Corn and tomatoes were grown in quartz sand, receiving various boron, potassium, and calcium treatments by the continuous flow method. Boron deficiency symptoms on the plants grown at deficient levels of boron in the nutrient solution were much more severe at high calcium levels than at the low levels of calcium. Boron toxicity, at high boron levels, decreased in intensity with increase in the calcium. The severity of boron deficiency symptoms on plants supplied with deficient quantities of boron, increased with increase in the potassium concentration. Boron toxicity, however, on the tomato plants, supplied with high concentrations of boron, increased in severity with increase in potassium concentration of the substrate. Quantitative determinations clearly show that the potassium concentration of the substrate has a definite influence upon the accumulation of boron in the tissues of corn and tomatoes. The calcium absorption at a given potassium and calcium level, increased as the boron concentration in the substrate increased.

Tomatoes and corn were found to be quite different in their sensitivity to small amounts of boron, and in their tolerance to high concentrations of boron. Corn will grow normally at a boron concentration lower than that required for normal growth of tomatoes. Tomatoes, however, are injured at a boron concentration much lower than that required to produce toxicity in corn.

These tests provide a convenient explanation of plant response often observed in the field, on soils deficient in boron, under different liming and fertilizer treatments.

The Use of Borax in Legume-Livestock Program of the South

H. E. Hendricks, University of Tennessee, Knoxville, Tenn.

It has been definitely determined in many of the Southern states that, with the addition of borax to the soil, legume forage production is increased both with respect to yields obtained per acre and by increasing the soil conditions and, thereby, the acreage upon which legume forage can be successfully produced.

Further to increase legume forage produc-

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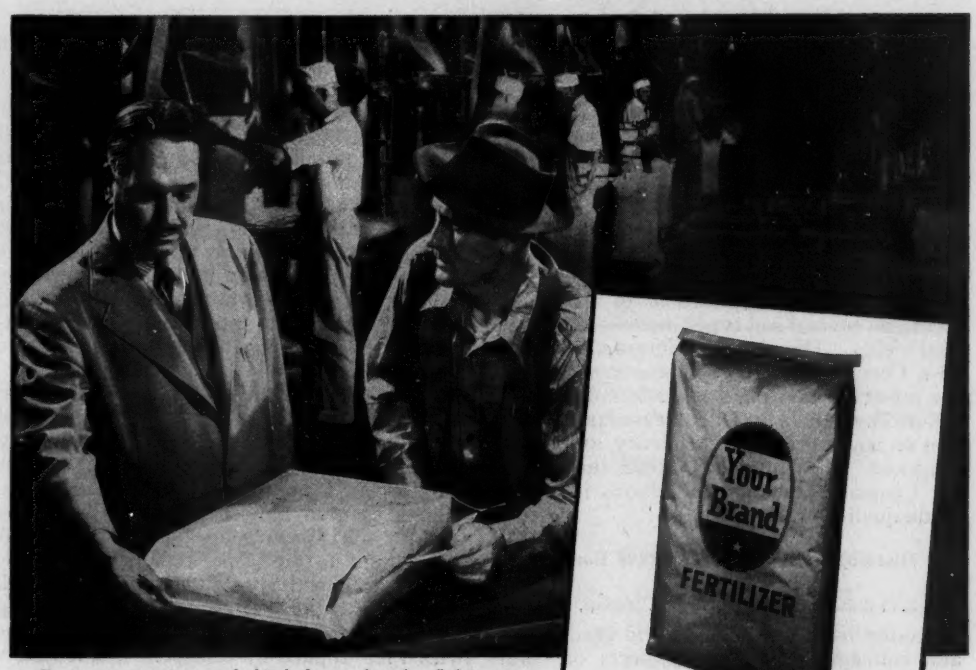

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tion in the South may require more home-grown seeds—at least, cheaper seeds, and the elimination of the major hazards of success from heretofore unfavorable soil and climatic conditions. Borax offers a contribution in solving some of these problems.

Borax is a limiting factor on most of the soil types of the South only after other limiting elements and materials, such as lime, phosphate, potash, and organic matter, or nitrogen, have been met.

That greater livestock production immediately follows increased forage production in the South has been proved in recent years and, with the use of borax opening new fields of opportunity in the expansion of forage production, livestock in the South should continue to increase, not only in numbers, but also livestock of better quality obtained from feeding more nutritious roughages.

The Importance of Borax in Legume Seed Production in the South

J. R. Piland, C. F. Ireland, and H. M. Reisenauer, North Carolina State College of Agriculture and Engineering of the University of North Carolina, Raleigh, N. C.

A review of current work in the South pertaining to the role of boron in seed production of various legumes is given.

Available boron in North Carolina soils range in concentration from 0.05 to 1.00 p.p.m. The supply of available soil boron is inadequate in many soils to meet the needs of legume plants. Application of borax to alfalfa on several soil types increased hay and seed yields. The yield of crimson clover seed on a Cecil sandy loam soil was increased by the use of borax. The application of borax to a Norfolk sandy loam soil increased pod formation on soybeans with a tendency to increase the yield. In a number of tests throughout the Coastal Plain borax additions improved grade quality of peanuts.

Histologic-Pathologic Effects of Boron Deficiency

J. C. Walker, University of Wisconsin, Madison, Wis.

Studies have been confined to garden beet and cabbage. The initial effects of boron deficiency appear as cell wall discoloration, discoloration of the protoplast, abnormal cell division, and abnormal cell enlargement. Disturbed and retarded cell differentiation follow. The seat of reaction is to be found in regions of high metabolic activity rather than in any particular region or tissue.

Microscopic pathologic-histologic areas commonly occur which never become macroscopic due to recovery from boron starvation. However, in view of the disturbed differentiation, particularly in transporting tissue, normal growth may be suppressed, accounting for frequently observed increase in yields without boron-deficiency symptoms. Permanent macroscopic symptoms result from extensive cell necrosis, usually in cambrium or active meustematic tissue, in which secondary cell responses such as wound periderm add to the disease pattern. The picture of pathological histology indicates strongly that boron is particularly important in cell division, tissue differentiation, and development of storage tissue.

THE PREPARATION OF AMMONIUM NITRATE

(*Continued from page 8*)

jecting a one-fourth inch layer of the product to a current of air of a given temperature and humidity, usually 80° F. and 72.5 per cent relative humidity. The results of several treatments are given in Table VII. Data for several synthetic resins and metal stearates are not included in the table as they were relatively ineffective moisture repellents. Other experiments show that the anti-caking agents, kieselguhr, kaolin and similar materials did not significantly influence moisture absorption.

The data of Table VII show that petrolatum and particularly the mixture of equal parts of petrolatum, rosin, and paraffin, PRP, are very effective moisture repellent coatings; 0.5 per cent is the maximum quantity of PRP required to give almost complete protection against the absorption of moisture. TVA ammonium nitrate (1 per cent petrolatum) is almost as effectively protected against high humidities as the laboratory product receiving the same treatment. Semi-works coatings with PRP applied by the spray method have likewise been as effective as those prepared in the laboratory.

The influence of moisture repellent coatings on caking has not been adequately determined.

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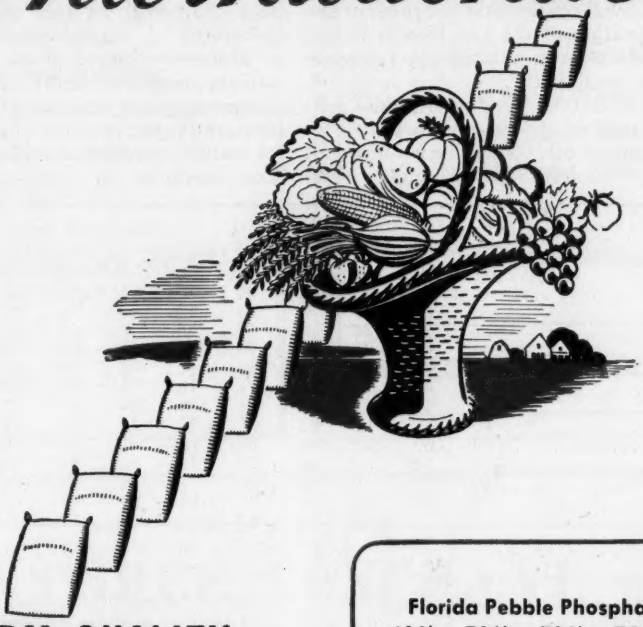

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Paraffin tends to increase caking of granular ammonium nitrate but observations to date indicate that 0.5 per cent PRP does not increase caking. The PRP treatment would be followed by the addition of kieselguhr or kaolin as anti-caking agents. The evaluation of the combined treatments in laboratory and large-scale storage tests is under way.

The influence of PRP coatings on the rate of availability of nitrogen in ammonium nitrate when used as a top dressing is being determined. Such coatings do not prevent the rapid disintegration of the granules in water, so it is unlikely that they have any influence on the rate of availability.

Regardless of any coating agent, chief reliance on the prevention of moisture absorption by ammonium nitrate will be shipment in good quality "moisture-proof" bags. The granule coatings may improve handling properties in elevators and over screens in the fertilizer plant. Their chief advantage will be improved handling properties for direct application.

TABLE VIII

AVERAGE MONTHLY TEMPERATURE, ° F., IN FERTILIZER CONSUMING REGIONS

Place	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Atlanta	42	41	52	59	69	75	76	76	71	60	51	42
Baltimore	33	31	42	53	64	72	76	74	68	56	45	35
Boston	28	26	36	46	57	66	71	69	63	53	42	32
Columbia, S. C.	44	44	55	61	70	76	78	76	72	61	51	44
Indianapolis	29	27	40	51	63	71	75	73	66	54	41	30
Montgomery	47	47	58	63	72	78	79	78	75	64	54	47
New Orleans	53	53	62	67	74	80	80	80	77	68	60	53
Norfolk	40	38	48	55	65	73	77	76	71	60	50	41
Raleigh	40	39	50	57	68	74	77	75	70	59	49	41
San Francisco	50	52	53	54	55	56	56	57	59	59	55	50
Savannah	49	49	57	63	71	77	79	78	74	65	56	49
Tampa	58	58	65	69	75	78	79	79	77	71	64	58

Evaluation of Climatic Factors Influencing Ammonium Nitrate

The handling properties of ammonium nitrate are materially influenced by the climatic conditions, temperature and humidity, to which it is subjected. The importance of these factors, especially the r 'mportance in different regions and seasons has been studied.

Temperature.—Temperature, as previously 'nd'cated, mater'ally 'ncreases the hygroscopicity, solubility and plasticity of ammonium nitrate. The average monthly temperature, therefore, has been determined from Weather Bureau records for a number of cities in the fertilizer consuming territory. The data are given in Table VIII.

The June-September temperatures, with the exception of San Francisco, average from 67° F. in Boston to 79° in New Orleans. All the Southern cities are in the range of 74° to 79° F. The winter temperatures, December-February, are 30° to 40° F. lower than the summer temperatures, with the exception of San Francisco, New Orleans and Tampa. Spring and fall temperatures average 10° to 20° lower than those of the summer months.

The importance of these temperature differences in the storage and handling properties of ammonium nitrate is indicated by the data of Tables I, II, and III. The latter indicates that caking at winter temperatures would be less than half as bad as at summer temperatures.

Moisture Content of the Air.—Ammonium nitrate absorbs moisture from the air when the aqueous vapor pressure of the air is greater than the vapor pressure of a saturated solution of ammonium nitrate. If, on the other hand, the condition is reversed the ammonium nitrate will dry out. The data of Table IX indicate the influence of place and season on moisture absorption by ammonium nitrate. The figures are the difference in the aqueous vapor pressure of air and of a saturated solution of ammonium nitrate at average monthly temperatures. When the difference is plus (+) ammonium nitrate will absorb moisture. Minus (−) figures indicate that ammonium nitrate would not absorb moisture from the

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When Boron deficiencies are found, follow the recommendations of local County Agents or State Experiment Stations.

Information and references available on request.

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Pioneer Producers of Muriate of Potash in America

See Page 4

air. The larger the figure the greater the rate of moisture absorption (+) or moisture loss (−) from the nitrate. All figures are monthly averages and are only intended to show seasonal trends and differences between regions.

A study of the data for Columbia, S. C. shows that ammonium nitrate will not absorb moisture under the average conditions prevailing in November to May, inclusive. Essentially the same condition prevails at Raleigh and Atlanta. In Indianapolis, moisture absorption would take place in July, August, and September, but even in those months the plus figures are much lower than in Columbia. New Orleans and Tampa have rather high plus figures for all months of the year. Norfolk has positive figures for eleven months but they are greater than 1.0 in only six of the eleven months.

These data and the temperature data show that the new forms of ammonium nitrate were introduced at the time of the year least favorable to the product. An apparent improvement in storage properties is expected in the fall and winter.

Bagging and Shipping Ammonium Nitrate

As previously indicated regardless of any moisture repellent coating, ammonium nitrate should be shipped in first class "moisture-proof" bags. Special care should be exercised in loading cars to prevent breaking or tearing bags in transit. This is more essential with a hygroscopic material like ammonium nitrate than with many other fertilizer materials.

Shipments of both TVA and Canadian ammonium nitrate have been received in which the bags were too full to permit much movement of the material in the bag. This increases caking and makes it difficult to break up a cake without breaking the bag.

Ammonium nitrate should be cooled to 100° F. or lower before it is bagged and shipped. There is little doubt but that a considerable portion of the caking difficulties encountered in early shipments of Nitraprills was due to shipments being made at high temperatures.

Recommendations

The following recommendations regarding the production of ammonium nitrate include what are considered the best procedures developed to date. Undoubtedly further improvements will be made as a result of additional research and plant experience.

1. Granulate ammonium nitrate by spraying or graining. Spraying is recommended for new production as it gives a better particle size distribution, 5 to 20 mesh, for direct application.
2. Coat ammonium nitrate granules with (a) 0.5 per cent petrolatum-rosin-paraffin and (b) 2.0–4.0 per cent kaolin or kieselguhr.
3. Bag and ship ammonium nitrate at temperatures not in excess of 100° F., preferably lower. Use first class, asphalt laminated, moisture-proof bags.
4. Avoid long storage during summer and early fall months.

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(2) Adams, J. R., and Ross, W. H. 1941. Relative Caking Tendency of Fertilizers. Ind. Eng. Chem. 33: 121–127.

(3) Hardesty, J. O., and Ross, W. H. 1938. Factors Affecting Granulation of Fertilizer Mixtures. Ind. Eng. Chem. 30: 668–672.

TABLE IX

AN INDEX OF PROBABLE MOISTURE ABSORPTION BY AMMONIUM NITRATE AS RELATED TO SEASONS AND REGIONS[1]

Difference between aqueous vapor pressure of the air and a saturated solution of ammonium nitrate (millimeters of mercury)

Place	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Atlanta	+0.19	−0.25	−0.06	−0.45	−0.38	+0.76	+2.54	+2.76	+1.34	+0.19	−0.14	+0.09
Baltimore	−0.37	−0.56	−0.45	−0.95	−0.44	+0.51	+1.02	+1.55	+1.38	+0.26	−0.39	−0.42
Boston	−0.33	.....	−0.40	−0.57	−1.54	+0.27	+1.03	+1.38	+1.20	+0.32	−0.12	−0.30
Columbia, S. C.	−0.13	−0.37	−0.36	−0.69	−0.41	+1.40	+2.51	+3.46	+2.20	+0.59	−0.32	−0.04
Indianapolis	+0.01	.....	−0.12	−0.35	−0.30	−0.02	+0.29	+0.57	+0.49	−0.13	−0.20	−0.09
Montgomery	+0.44	+0.14	+0.41	−0.07	+0.14	+1.27	+2.81	+3.50	+1.96	+0.64	+0.22	+0.32
New Orleans	+1.19	+0.87	+1.58	+1.45	+2.13	+2.99	+4.04	+4.45	+3.70	+1.89	+1.52	+1.03
Norfolk	+0.11	−0.03	+0.28	+0.20	+1.15	+2.47	+3.47	+3.81	+2.66	+1.44	+0.33	+0.11
Raleigh	−0.15	−0.44	−0.27	−0.77	+0.03	+1.46	+2.56	+3.07	+2.02	+0.65	−0.24	−0.13
San Francisco	+0.47	+0.29	+0.09	0.00	+0.40	+0.64	+1.22	+1.43	+0.79	+0.30	+0.32	+0.18
Savannah	+0.49	+0.33	+0.99	+0.87	+2.04	+3.44	+4.31	+4.81	+4.29	+2.15	+0.97	+0.58
Tampa	+1.56	+1.47	+1.88	+1.39	+2.11	+3.71	+4.54	+4.88	+4.54	+2.88	+2.02	+1.77

[1]Plus (+) figures indicate ammonium nitrate will absorb moisture while minus (−) figures indicate it will lose moisture if damp.

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OUR PAY ENVELOPE today *is* dynamite.

The wrong way to handle it is for us to wink at prices that look too steep . . . telling ourselves we can afford to splurge.

We *can't* afford to—whether we're business men, farmers, or workers. And here's why:

Splurging will boost prices. First on one thing, then all along the line.

Then, wages will have to go up to meet higher prices. And higher wages will push prices up some more . . . faster and faster.

The reason this can happen is that, this year, we Americans will have *45 billion* dollars more income than there are goods and services to buy at present prices.

That's the dynamite!

The RIGHT way to handle it . . . and why

Our Government is doing a lot of things to keep the cost of living from snowballing.

But the real control is in *our* hands. Yours. Mine.

KEEP PRICES DOWN!

It won't be fun. It will mean sacrifice and penny-pinching. But after all, the sacrifice of tightening our belts and doing without is a small sacrifice compared with giving your life or your blood in battle!

Here's what YOU must do

Buy only what you absolutely need.

Don't ASK higher prices—for your own labor, your own services, or goods you sell.

Buy rationed goods only by exchanging stamps.

Don't pay a cent above ceiling prices.

Take a grin-and-bear-it attitude on taxes. They must get heavier.

Pay off your debts. Don't make new ones.

Start a savings account. Buy and keep up adequate life insurance.

Buy more War Bonds.

If we do these things, we and our Government won't have to fight a postwar battle against collapsing prices and paralyzed business.

Use it up
Wear it out
Make it do
Or do without

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Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

CRANES AND DERRICKS
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

CYANAMID
American Agricultural Chemical Co., New York City
American Cyanamid Co., New York City.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Jett, Joseph C., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

DENS—Superphosphate
Chemical Construction Corp., New York City.
Stedman's Foundry and Mach. Works, Aurora, Ind.

Andrew M. Fairlie
CHEMICAL ENGINEER
22 Marietta Street Building ATLANTA, GA.
CABLE ADDRESS: "SULFACID ATLANTA"

SULPHURIC Acid Plants . . . Design, Construction, Equipment . . . Operation . . . Mills-Packard Water-Cooled Acid Chambers, Gaillard Acid-Cooled Chambers, Gaillard Acid Dispersers, Contact Process Sulphuric Acid Plants.

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Stedman's Foundry and Mach. Works, Aurora, Ind.

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Sackett & Sons Co., The A. J., Baltimore, Md.

DRIVES—Electric
Link-Belt Company, Philadelphia, Chicago.

DUMP CARS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DUST COLLECTING SYSTEMS
Sackett & Sons Co., The A. J., Baltimore, Md.

ELECTRIC MOTORS AND APPLIANCES
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ELEVATORS
Atlanta Utility Works, East Point, Ga.
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ELEVATORS AND CONVEYORS—Portable
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Sackett & Sons Co., The A. J., Baltimore, Md.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ENGINES—Steam
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

EXCAVATORS AND DREDGES—Drag Line and Cableway
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.

FERTILIZER MANUFACTURERS
American Agricultural Chemical Co., New York City.
American Cyanamid Company, New York City.
Armour Fertilizer Works, Atlanta, Ga.
Farmers Fertiliser Company, Columbus, Ohio.
International Minerals and Chemical Corporation, Chicago, Ill.
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

FISH SCRAP AND OIL
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
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McIver & Son, Alex. M., Charleston, S. C.
Wellmann, William E., Baltimore, Md.

FOUNDERS AND MACHINISTS
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Link-Belt Company, Philadelphia, Chicago.
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Stedman's Foundry and Mach. Works, Aurora, Ind.

GARBAGE TANKAGE
Wellmann, William E., Baltimore, Md.

GEARS—Machine Moulded and Cut
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GEARS—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

GELATINE AND GLUE
American Agricultural Chemical Co., New York City.

GUANO
Baker & Bro., H. J., New York City.

HOISTS—Electric, Floor and Cage Operated, Portable
Hayward Company, The, New York City.

HOPPERS
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Stedman's Foundry and Mach. Works, Aurora, Ind.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

IRON SULPHATE
Tennessee Corporation, Atlanta, Ga.

INSECTICIDES
American Agricultural Chemical Co., New York City.

LACING—Belt
Sackett & Sons Co., The A. J., Baltimore, Md.

LIMESTONE
American Agricultural Chemical Co., New York City.
American Limestone Co., Knoxville, Tenn.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
McIver & Son, Alex. M., Charleston, S. C.
Wellmann, William E., Baltimore, Md.

LOADERS—Car and Wagon, for Fertilizers
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Duriron Co., Inc., The, Dayton, Ohio.
Fairlie, Andrew M., Atlanta, Ga.
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Coal and Ash Handling
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, East Point, Ga.
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Grinding and Pulverizing
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
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MACHINERY—Tankage and Fish Scrap
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MAGNETS
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MANGANESE SULPHATE
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Tennessee Corporation, Atlanta, Ga.

MIXERS
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Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

NITRATE OVENS AND APPARATUS
Chemical Construction Corp., New York City.

NITROGEN SOLUTIONS
Barrett Division, The, Allied Chemical & Dye Corp., New York City.

NITROGENOUS ORGANIC MATERIAL
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., Wilmington, Del.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

PANS AND POTS
Stedman's Foundry and Mach. Works, Aurora, Ind.

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Chemical Construction Corp., New York City.

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Huber & Company, New York City.
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McIver & Son, Alex. M., Charleston, S. C.
Phosphate Mining Co., The, New York City.
Ruhm, H. D., Mount Pleasant, Tenn.
Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Virginia–Carolina Chemical Corp. (Mining Dept.), Richmond, Va.
Wellmann, William E., Baltimore, Md.

PIPE—Acid Resisting
Duriron Co., Inc., The, Dayton, Ohio.

PIPES—Chemical Stoneware
Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers
American Potash and Chem. Corp., New York City.
Potash Co. of America, New York City.
International Minerals & Chemical Corp., Chicago, Ill.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., New York City.
Wellmann, William E., Baltimore, Md.

QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

RINGS—Sulphuric Acid Tower
Chemical Construction Corp., New York City.

ROUGH AMMONIATES
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McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
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SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Including Vibrating
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Magnetic
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SHOVELS—Power
Link-Belt Company, Philadelphia, Chicago.
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SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

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STACKS
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SULPHATE OF AMMONIA
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Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
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SYPHONS—For Acid
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TALLOW AND GREASE
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TANKAGE
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Armour Fertilizer Works, Atlanta, Ga.
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McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Smith-Rowland, Norfolk, Va.
Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

TANKS
Sackett & Sons, Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

TOWERS—Acid and Absorption
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

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Sackett & Sons Co., The A. J., Baltimore, Md.

UREA
DuPont de Nemours & Co., E. I., Wilmington, Del.

UREA-AMMONIA LIQUOR
DuPont de Nemours & Co., E. I., Wilmington, Del.

VALVES—Acid-Resisting
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Investigate

ERONITE

(a conditioner and filler)

SAMUEL D. KEIM

(SINCE 1898)

1612 MARKET STREET

PHILADELPHIA 3, PA.

MONARCH SPRAYS

This is our Fig. 645 Nozzle. Used for Scrubbing Acid Phosphate Gases. Made for "full" or "hollow" cone in Brass and "Everdur." We also make "Non-Clog" Nozzles in Brass and Steel, and

Stoneware Chamber Sprays

now used by nearly all chamber spray sulphuric acid plants.

CATALOG 6-C

MONARCH MFG. WORKS, INC.
Westmoreland and Emery Sts., Philadelphia, Pa.

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Use this Hayward Class "K" Clam Shell for severe superphosphate digging and handling.

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GASCOYNE & CO., INC.
Established 1887
Chemists and Assayers
Public Weighers and Samplers
27 South Gay Street - BALTIMORE, MD.

Stillwell & Gladding
Established 1868
WE MAKE ANALYSES OF ALL KINDS
130 Cedar Street : : NEW YORK

The Farmers Fertilizer Co.
Manufacturers
COMPLETE FERTILIZERS
BULK SUPERPHOSPHATE
SULPHURIC ACID
Acid plant capacity, 45,000 tons. Fertilizer plant capacity, 50,000 ton
Get in touch with us COLUMBUS, OHIO

SHUEY & COMPANY, Inc.
Specialty: Analysis of Fertilizer Materials and Phosphate Rock. Official Chemists for both Florida Hard Rock Phosphate and Pebble Phosphate Export Associations. Official Weigher and Sampler for the National Cottonseed Products Association at Savannah; also Official Chemists for National Cottonseed Products Association.
115 E. BAYSTREET, SAVANNAH, GA.

H. D. RUHM
Phosphate Consultant
305 W. 7th Street
COLUMBIA TENNESSEE

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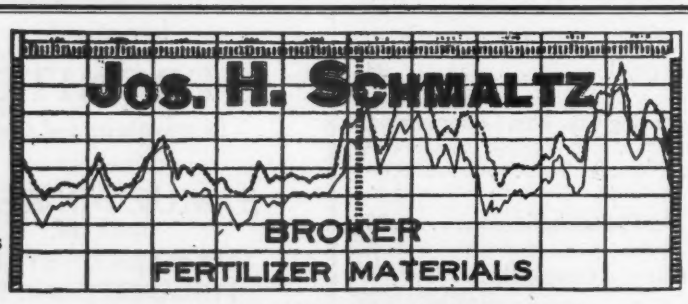
NATURAL CHILEAN NITRATE

Sulphur that's ideal for the Fertilizer Industry
AMPLE STOCKS OF 99⅕% PURE SULPHUR
TEXAS GULF SULPHUR CO
11-TG-2

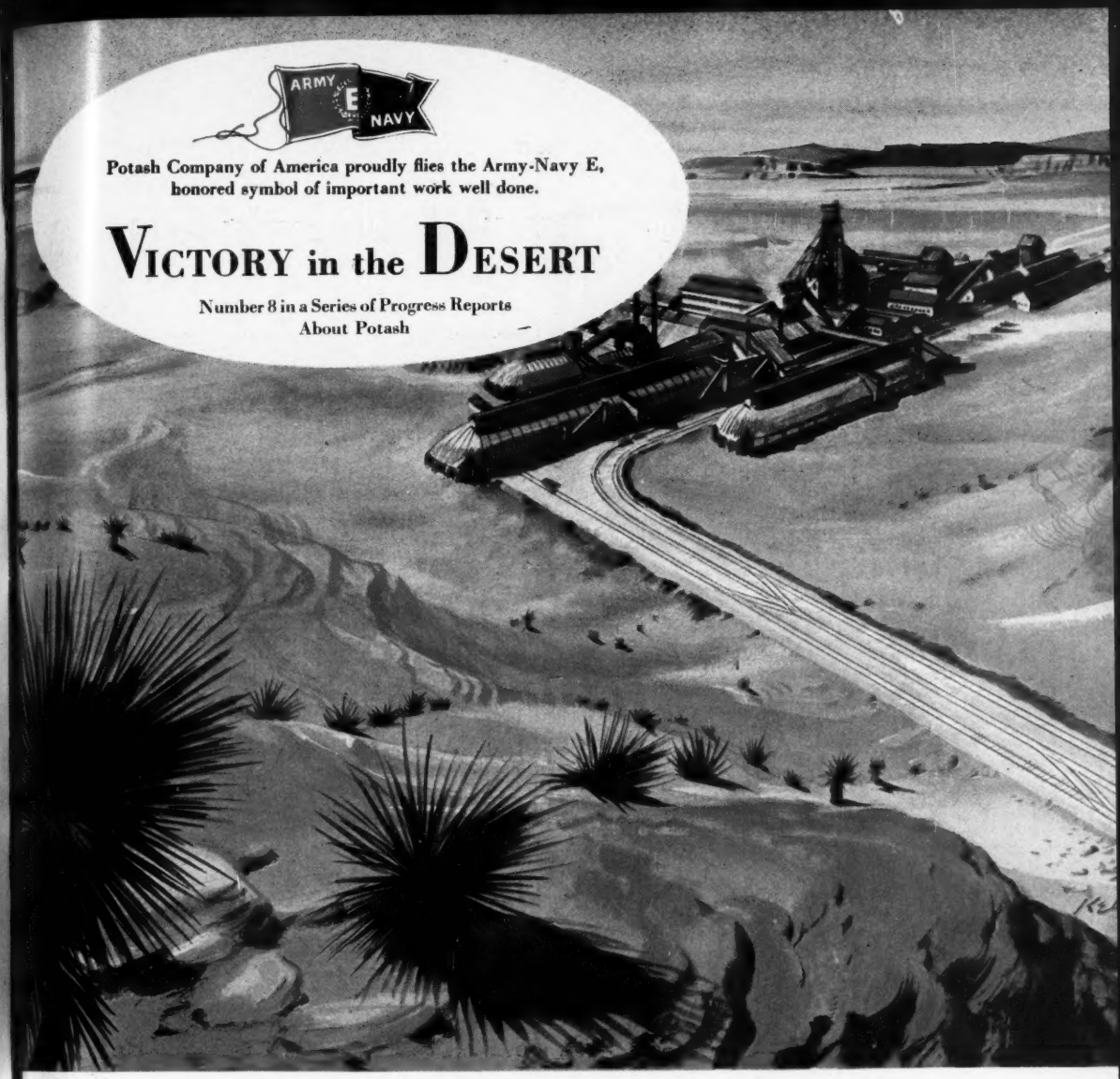
WILEY & COMPANY, Inc.
Analytical and Consulting Chemists
BALTIMORE, MD.

Tankage
Blood
Bone
All
Ammoniates



327 South La Salle Street CHICAGO

OFFICIAL BROKER FOR MILORGANITE



Potash Company of America proudly flies the Army-Navy E, honored symbol of important work well done.

VICTORY in the DESERT

Number 8 in a Series of Progress Reports About Potash

BAKING UNDER DESERT SUN...

It is hard to believe that under this parched area of New Mexico are large deposits of a substance vital to agriculture and to industry — Potash.

Yet there they are, deep down below.

This Potash Company of America plant at Carlsbad is a monument to a great desert victory — a victory which took years to win, and which has helped to make America's Potash wealth available.

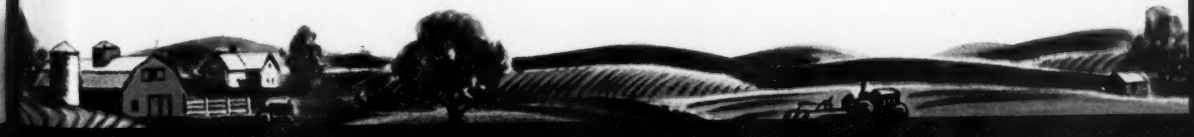
This plant — with others in the industry — is now producing to the limit. Agriculture could use it all, no doubt, but war industry must have its share. That is why, in spite of the great desert victory, you may not be able to get all the Potash you would like to have.

PCA RED MURIATE

POTASH COMPANY OF AMERICA

CARLSBAD, NEW MEXICO

GENERAL SALES OFFICE...50 Broadway, New York, N. Y. • SOUTHERN SALES OFFICE...Mortgage Guarantee Building, Atlanta, Ga.



There are also Sulphate of Ammonia producing plants in California, Colorado and Utah. Sulphate of Ammonia is produced within easy shipping distance of all fertilizer-consuming areas.

PLANT FOOD FROM COAL

Forty years ago, the production of by-product Domestic Sulphate of Ammonia was by an infant industry. Today, the recovery of Nitrogen from coal by modern coke ovens – and by gas plants serving U. S. cities – is a vast enterprise, a vital source of America's agricultural and industrial strength.

The significance of *plant food from coal* to the wartime Nitrogen supply is demonstrated by the fact that production of by-product Domestic Sulphate of Ammonia is expected to be well in excess of 800,000 tons during the 1943-44 fertilizer year.

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N. Y.
133 CARNEGIE WAY, ATLANTA 3, GA.

Barrett NITROGEN

HEADQUARTERS FOR AMERICAN-MADE NITROGEN

BARRETT NITROGEN SOLUTIONS ★ DOMESTIC SULPHATE AMMONIA ★ *ARCADIAN, THE AMERICAN NITRATE OF SODA

*REG. U. S. PAT. OFF.